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RV POSEIDON-CRUISE POS496

Malaga – Catania, 24.03.2016 - 04.04.2016

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Short Cruise Report

MAGOMET

Offshore flank movement of Mount Etna and associated
landslide hazard in the Ionian Sea (Mediterranean Sea)

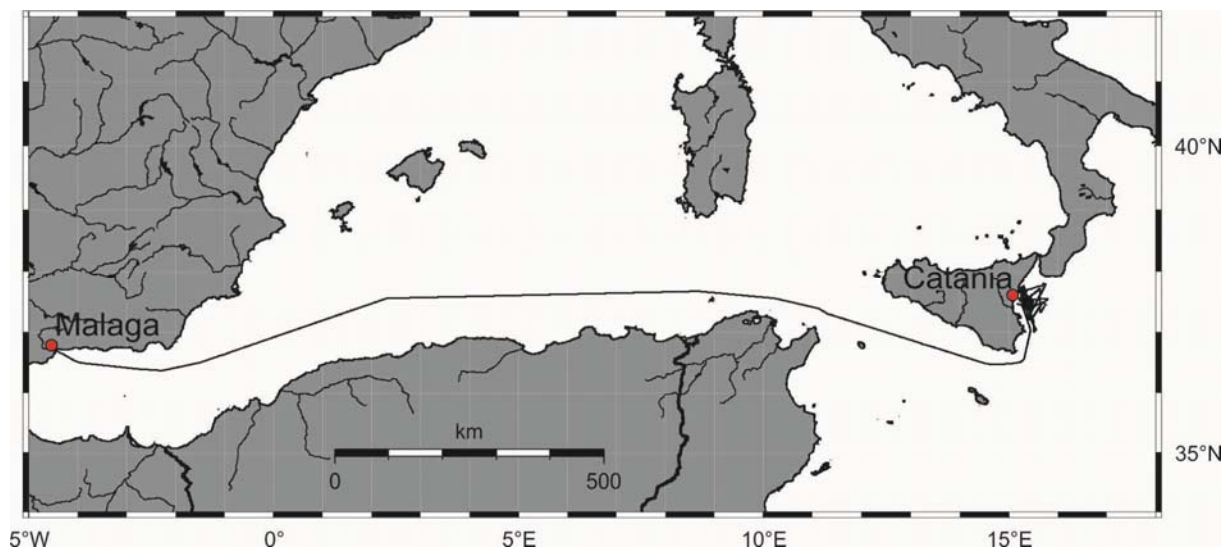


Fig 1: Track chart Cruise POS496 (Malaga - Catania).

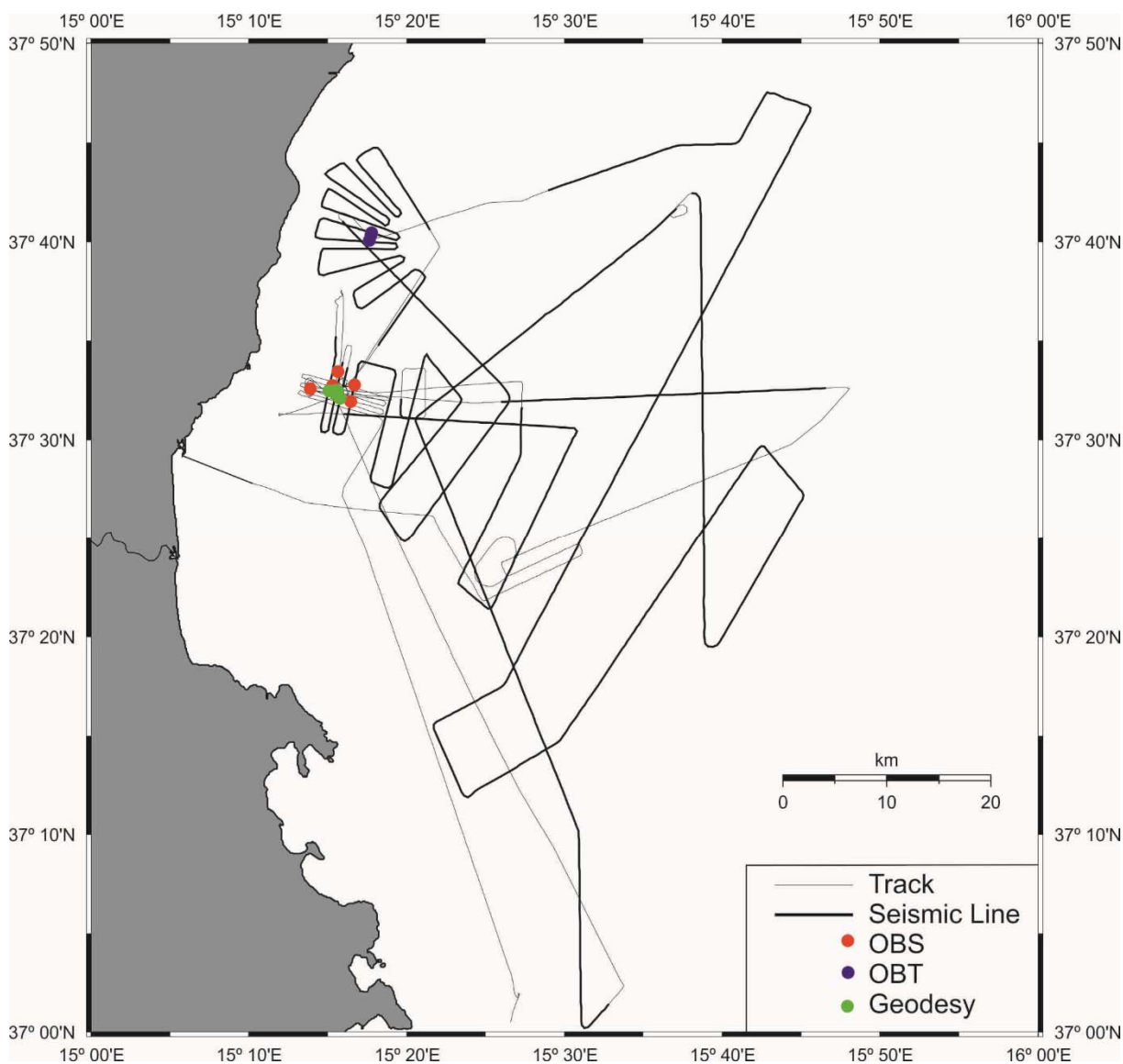


Fig 2: Detailed track chart of the POS496 working area.

Objectives

The south Italian coastline with its many famous tourist areas is exposed to a number of geohazards. The Calabrian Arc subduction zone is responsible for high seismicity and active volcanism. The largest and currently most active volcano in Europe is Mount Etna located in southern Sicily. Eruptions, shallow seismicity as well as surface fracturing occur frequently. Over the past 20 years, extensive geodetic surveys of the summit and onshore flanks of Mount Etna have revealed instability of its eastern flank, which continuously moves seawards with horizontal displacement rates of up to 50 mm/yr. Catastrophic failure of these parts of the volcanic edifice, as they occurred for example in the Hawaiian and Canary chains, would likely result in a large tsunami in the Mediterranean Sea. Numerous hypotheses to explain the observed flank instability have been brought forward, but a rigorous understanding of the underlying processes is masked by a lack of information on the dynamics of the submerged offshore part of the flank. To fill this gap in knowledge, we deployed a geodetic array during Cruise POS496 and collected seismic data.

In detail we seek to answer the following questions:

- 1) What are the displacement rates along the southern boundary of Mount Etna's unstable flank? What is the areal extent of the unstable flank?
- 2) Is the crest of the amphitheatre the offshore expression of the Timpe wedge?
- 3) How stable is the crest of the amphitheatre structure?

The deployment of seafloor instruments included precision acoustic transponders (Autonomous Monitoring Transponder, AMT), Ocean Bottom Tiltmeters (OBT) and Ocean Bottom Seismometers (OBS). The AMTs transmit acoustic signals to provide two-way travel times in repeated interrogations to determine horizontal displacements of the seafloor. Vertical displacement is measured by monitoring pressure variations at the seafloor. A geodetic array consisting of five AMTs were deployed across the postulated offshore southern boundary of Mount Etna's unstable flank. Six OBS were deployed around this geodetic array to record local seismicity that could be linked to displacements. OBTs can provide quasi-continuous high precision data of ground dynamics. Three OBTs were deployed close to the edge of the crest of an offshore submarine amphitheatre to monitor internal displacements of the unstable flank. The high-resolution seismic system consisted of one Mini-GI gun and an 88-channel 137.5 m m-long digital Geometrics GeoEel streamer. This system is optimized for collecting high-resolution seismic data, which allows resolution of small-scale sedimentary structures and closely spaced layers on a meter scale, which usually cannot be resolved by means of conventional seismic systems. Several tectonic features off Mount Etna's Eastern flank were surveyed. Multibeam data were collected with an Elac SB3050 multibeam system, which is permanently installed on RV Poseidon.

Narrative

The scientific party arrived in Malaga on March 23rd. The equipment was already loaded by the crew of RV POSEIDON. The time until departure was used to set up the labs. RV POSEIDON left the port of Malaga on March 24th at 13:00h at very pleasant weather conditions (sunny skies and calm seas).

The scientific crew of Cruise POS496 included five scientists from the GEOMAR, three scientist from the Christian-Albrechts-Universität zu Kiel, and one scientist from the University

of Malta. The long transit to the working area was used for setting up all equipment and testing the instruments.

The scientific program started on March 28th at 17:00h local time with the collection of a sound velocity profile and a test of the release units at the southernmost part of our working area. The test was successful; afterwards we headed to the deployment area of the OBS and ATMs (geodetic array). The night was used for collecting additional multibeam data across the planned geodesy deployment array. The geodetic array should be deployed at a lineament north of Catania Canyon, which we consider as the southern boundary of the moving flank. March 29th was a very successful day supported by perfect weather conditions. The morning was used for deploying OBS (free-floating devices), which will record seismicity for the next year. This deployment was followed by calibrating the USBL system (Posidonia), which is essential for the accurate positioning of the AMTs. The first AMT was deployed in the afternoon. The AMTs are deployed from the Poseidon for the first time; handling of the stations was done in a very professional way. After successful deployment of the first station, we started a seismic survey of the seaward continuation of the lineament. Around midnight, a leakage of the streamer was indicated and the streamer was recovered. The faulty part was quickly identified and seismic surveying was continued until 6:30h. March 30th was another very successful day. We planned to deploy two AMTs but due to the quick progress and perfect weather conditions, we managed to deploy three stations. The night was used for seismic surveying of the upper crest of a major amphitheater in order to assess its stability and to investigate if it represents the offshore expression of the Timpe wedge. The survey lasted until March 31st 08:00h. The last AMT was deployed on March 31st in the morning. Despite the rough morphology, all AMTs can communicate with each other and baselines for different targets were set up successfully. This was the main objective of the cruise, which was already met after three working days. Thereafter, we tested the releaser units for the OBTs. The seismic gear was deployed at 16:00h. We collected seismic profiles across the OBS and the geodetic array as well as some additional profiles across the lineament. The survey was interrupted for a short time in the evening of 31.03, as we had to reduce some flotation from the streamer. Seismic surveying was continued until April 1st, 09:00h. The profile ended at the crest of the amphitheater, which was the deployment area for the OBT. The OBTs were deployed very close to the crest of the amphitheater for monitoring the stability of the slope. The deployment of the three tiltmeters was quick and smooth. After a short transit, we started with seismic surveying at 13:00h. Main target of this survey was the lower continental slope. We wanted to image tectonic features with prominent surface expressions visible on bathymetric maps. In addition, a long profile to the south (to 37°N) seaward of the Malta Escarpment was collected in order to connect our seismic data to an existing seismic network further south. The wind picked up on April 2nd (Beaufort 7-8) but data quality was still reasonable. The survey was interrupted shortly in the evening of April 2nd, as we lost the end buoy of the streamer, which was replaced quickly. The seismic system was retrieved the next morning at 08:00h. Thereafter we headed back to the deployment area of the geodetic array in order to check that the system is fully operational and to read out the first data. This test was successful. A last short seismic survey testing a Micro-GI gun started on April 3rd at 15:00h; we retrieved the seismic gear at 20:00h. We used the remaining hours for filling some gaps in bathymetric coverage. Research activities ended on April 4th at 02:16h before we started our very short transit to Catania. We arrived in Catania on April 4th at 09:30h.

Acknowledgements

The scientific party of RV Poseidon Cruise POS496 gratefully acknowledges the very friendly and most effective cooperation with Captain Günther and his crew. Their perfect technical assistance substantially contributed to make this cruise a scientific success. The expedition was funded by the Deutsche Forschungsgemeinschaft and the Bundesministerium für Bildung und Forschung.

Participants

Name	Discipline	Institution
Krastel, Sebastian	Chief Scientist	CAU
Krabbenhoeft, Anne	Geodesy/OBS/OBT	GEOMAR
Hannemann, Katrin	Geodesy/OBS/OBT	GEOMAR
Petersen, Florian	Geodesy/OBS/OBT	GEOMAR
Schröder, Patrick	Technician	GEOMAR
Steffen, Klaus-Peter	Technician	GEOMAR
Gross, Felix	Seismics/Hydroacoustics	CAU
Schulze, Inken	Seismics/Hydroacoustics	CAU
Micallef, Aaron	Seismics/Hydroacoustics	UoM

CAU	Christian-Albrechts-Universität zu Kiel
GEOMAR	Helmholtz Centre for Ocean Research Kiel
UoM	University of Malta

POS496-Station List

Stationlist Poseidon Cruise POS496

GDS: Geodesy stations, REL: Releaser Test

OBS: Ocean Bottom Seismometer, OBT: Ocean Bottom Tiltmeter

MB: Multibeam, SEISREFL: Seismic Reflection,

POS: Posidonia callibration (USBL-system)

Station No.		Date	Gear	Time	Lat	Long	Water Depth	Remarks/Recovery
POS 4961/	GEOMAR/CAU	2016		[UTC]	[°N]	[°E]	[m]	
049-1		28.3	REL	16:07	37° 01,91'	15° 27,07'	2489	
050-1		28.3	MB	20:51	37° 31,13'	15° 18,27'	1764	
051-1		29.3	POS	04:20	37° 32,59'	15° 13,89'	770.5	not successfull
052-1	OBS2	29.3	OBS	06:22	37° 32,12'	15° 15,72'	1171	
053-1	OBS1	29.3	OBS	06:49	37° 31,94'	15° 16,47'	1347	
054-1	OBS4	29.3	OBS	07:14	37° 33,45'	15° 15,64'	1063	
055-1	GDS6	29.3	GDS	07:32	37° 32,75'	15° 15,31'	971	
056-1	OBS5	29.3	OBS	07:56	37° 32,77'	15° 16,70'	1294	
057-1		29.3	POS	08:36	37° 32,59'	15° 13,90'	767.4	
058-1	OBS3	29.3	OBS	10:38	37° 32,60'	15° 13,88'	771.3	
059-1	GDS1	29.3	GDS	11:38	37° 32,28'	15° 15,49'	1086	
060-1		29.3	SEISREFL	15:28	37° 31,29'	15° 15,96'	1428	see separate list
061-1	GDS2	30.3	GDS	06:33	37° 32,48'	15° 15,53'	1050	
062-1	GDS3	30.3	GDS	08:34	37° 32,46'	15° 15,06'	957	
063-1	GDS4	30.3	GDS	10:51	37° 32,09'	15°15,80'	1182	
064-1		30.3	SEISREFL	15:20	37° 35,74'	15° 19,03'	1237	see separate list
065-1	GDS5	31.3	GDS	07:30	37° 32,44'	15° 15,62'	1059	
066-1		31.3	REL	11:05	37° 37,34'	15° 15,97'	752	
067-1		31.3	SEISREFL	14:30	37° 34,18'	15° 15,47'	894	see separate list
068-1	OBT1	1.4	OBT	07:54	37° 40,46'	15° 17,81'	624	
069-1	OBT2	1.4	OBT	08:34	37° 40,33'	15° 17,74'	620	
070-1	OBT3	1.4	OBT	09:14	37° 40,06'	15° 17,66'	626.1	
071-1		1.4	SEISREFL	11:14	37°42,48'	15° 28,60'	1753	see separate list
072-1		3.4	GDS	10:55	37°32,33'	15°15,46'	1077	check only
073-1		3.4	SEISREFL	13:27	37°31,87'	15°24,56'	2022	see separate list
074-1		3.4	MB	21:02	37°24,98'	15°29,53'	2151	

List of moored instruments:

Station	Deployment at seafloor (from Posidonia)			
	Date / UTC Time	LAT (N)	LON (E)	DEPTH
	(dd.mm.yy / hh:mm)	D:M	D:M	(m)
GDS 1	29.03.16 / 11:41	37°32.294	15°15.510	1090
GDS 2	30.03.16 / 07:36	37°32.499	15°15.522	1050
GDS 3	30.03.16 / 09:35	37°32.467	15°15.054	976
GDS 4	30.03.16 / 12:35	37°32.112	15°15.797	1182
GDS 5	31.03.16 / 08:30	37°32.459	15°15.635	1073
GDS 6	29.03.16 / 07:32	37°32.748	15°15.315	978
OBS 1	29.03.16 / 06:48	37°31.937	15°16.473	1339
OBS 2	29.03.16 / 06:23	37°32.122	15°15.721	1171
OBS 3	29.03.16 / 10:38	37°32.597	15°13.879	767
OBS 4	29.03.16 / 07:14	37°33.443	15°15.636	1059
OBS 5	29.03.16 / 07:56	37°32.774	15°16.702	1294
OBT 1	01.04.16 / 08:14	37°40.443	15°17.789	624
OBT 2	01.04.16 / 08:54	37°40.337	15°17.739	620
OBT 3	01.04.16 / 09:34	37°40.066	15°17.661	628

Stations GDS1 to GDS6 communicate with a frequency of 18 kHz.

List of seismic profiles

Profil-Nr. GeoEEL	Date	Time Start	Time End End	Latitude Start	Longitude Start	Latitude End	Longitude End	Geometrics	Geometrics
								FFN Start	FFN End
				Start	End	FFN Start	FFN End		
POS496		UTC	UTC	xx° xx.x'	xx° xx.x'	xx° xx.x'	xx° xx.x'		
P100	29.03.2016	15:31	16:30	37°31.292	15°16.050	37°31.07	15°20.90	90	704
P101	29.03.2016	18:04	18:23	37°32.18	15°19.65	37°31.11	15°19.71	800	989
P102	29.03.2016	18:23	20:33	37°31.11	15°19.71	37°30.552	15°30.704	989	2345
P103	29.03.2016	20:33	22:26	37°30.552	15°30.704	37°23.850	15°26.811	2345	3531
P200	30.03.2016	00:35	01:20	37°24.290	15°26.917	37°21.531	15°25.424	4000	4463
P201	30.03.2016	01:20	01:54	37°21.531	15°25.424	37°22.674	15°23.267	4463	4817
P202	30.03.2016	01:54	02:37	37°22.674	15°23.267	37°28.787	15°26.982	4817	5865
P203	30.03.2016	02:37	04:28	37°28.787	15°26.982	37°31.831	15°27.292	5865	6411
P300	30.03.2016	14:59	16:04	37°34.65	15°18.09	37°38.20	15°21.16	7000	7692
P301	30.03.2016	16:04	16:14	37°38.20	15°21.16	37°38.59	15°20.53	7692	7789
P302	30.03.2016	16:14	17:04	37°38.59	15°20.53	37°36.61	15°17.13	7789	8304
P303	30.03.2016	17:04	17:20	37°36.61	15°17.13	37°37.51	15°16.68	8304	8477
P304	30.03.2016	17:20	18:10	37°37.51	15°16.68	37°39.29	15°19.64	8477	8988
P305	30.03.2016	18:10	19:12	37°39.29	15°19.64	37°38.303	15°14.61	8988	9627
P306	30.03.2016	19:12	19:33	37°38.303	15°14.61	37°39.510	15°14.585	9627	9832
P307	30.03.2016	19:33	20:28	37°39.510	15°14.585	37°39.629	15°19.247	9832	10410
P308	30.03.2016	20:28	21:33	37°39.629	15°19.247	37°40.173	15°14.329	10410	11079
P309	30.03.2016	21:33	21:48	37°40.173	15°14.329	37°41.086	15°14.499	11079	11235
P310	30.03.2016	21:48	22:55	37°41.086	15°14.499	37°40.22	15°19.55	11235	11927

Profil-Nr. GeoEEL	Date	Time Start	Time End End	Latitude Start	Longitude Start	Latitude End	Longitude End	Geometrics FFN Start	Geometrics FFN End
				Start		End		FFN	FFN
		UTC	UTC	xx° xx.x'	xx° xx.x'	xx° xx.x'	xx° xx.x'	Start	End
POS496									
P311	30.03.2016	22:55	00:03	37°40.22	15°19.55	37°41.85	15°14.59	11927	12630
P312	31.03.2016	00:03	00:19	37°41.85	15°14.59	37°42.65	15°15.07	12630	12795
P313	31.03.2016	00:19	01:20	37°42.65	15°15.07	37°41.21	15°18.79	12795	13425
P314	31.03.2016	01:20	02:17	37°41.21	15°18.79	37°43.38	15°14.85	13425	14018
P315	31.03.2016	02:17	02:33	37°43.38	15°14.85	37°43.98	15°15.88	14018	14181
P316	31.03.2016	02:33	03:32	37°43.98	15°15.88	37°41.24	15°19.35	14181	14798
P317	31.03.2016	03:32	03:43	37°41.24	15°19.35	37°41.55	15°19.58	14798	14870
P318	31.03.2016	03:43	04:28	37°41.55	15°19.58	37°44.09	15°16.83	14870	15369
P319	31.03.2016	04:28	06:05	37°44.09	15°16.83	37°40.554	15°21.505	15369	16374
P400	31.03.2016	14:13	15:28	37°35.27	15°15.05	37°30.40	15°15.64	17000	17773
P401	31.03.2016	15:28	16:30	37°30.40	15°15.64	37°34.11	15°16.00	17773	18412
P500	31.03.2016	17:03	17:54	37°33.77	15°16.28	37°30.38	15°15.35	19000	19533
P501	31.03.2016	17:54	18:58	37°30.38	15°15.35	37°33.96	15°17.13	19533	20189
P502	31.03.2016	18:58	19:24	37°33.96	15°17.13	37°33.49	15°19.25	20189	20457
P503	31.03.2016	19:24	20:48	37°33.49	15°19.25	37°28.033	15°17.69	20457	21327
P504	31.03.2016	20:48	21:03	37°28.033	15°17.69	37°27.561	15°18.784	21327	21484
P505	31.03.2016	21:03	22:50	37°27.561	15°18.784	37°34.30	15°21.19	21484	22588
P506	31.03.2016	22:50	23:34	37°34.30	15°21.19	37°32.06	15°23.47	22588	23045
P507	31.03.2016	23:34	01:14	37°32.06	15°23.47	37°26.85	15°18.32	23045	24077
P508	01.04.2016	01:14	01:51	37°26.85	15°18.32	37°24.83	15°19.88	24077	24459
P509	01.04.2016	01:51	04:05	37°24.83	15°19.88	37°31.98	15°26.49	24459	25846
P510	01.04.2016	04:05	07:14	37°31.98	15°26.49	37°41.172	15°15.727	25846	27802
P600	01.04.2016	11:33	13:44	37°42.93	15°30.22	37°44.93	15°40.83	28051	29413
P601	01.04.2016	13:44	14:32	37°44.93	15°40.83	37°47.52	15°47.52	29413	29889
P602	01.04.2016	14:32	14:07	37°47.52	15°47.52	37°46.74	15°45.58	29889	30270
P603	01.04.2016	14:07	18:11	37°46.74	15°45.58	37°36.007	15°38.50	30270	32155
P604	01.04.2016	18:14	23:17	37°35.481	15°38.388	37°17.63	15°26.19	32200	35330
P605	01.04.2016	23:17	00:19	37°17.63	15°26.19	37°15.63	15°21.78	35330	35977
P606	02.04.2016	00:19	01:18	37°15.63	15°21.78	37°11.95	15°23.66	35977	36586
P607	02.04.2016	01:18	02:43	37°11.95	15°23.66	37°14.71	15°29.67	36586	37473
P608	02.04.2016	02:43	07:18	37°14.71	15°29.67	37°29.651	15°42.400	37473	40302
P609	02.04.2016	07:18	08:06	37°29.651	15°42.400	37°27.302	15°45.101	40302	40809
P610	02.04.2016	08:06	10:15	37°27.302	15°45.101	37°19.53	15°39.61	40809	42148
P611	02.04.2016	10:15	15:59	37°19.53	15°39.61	37°42.048	15°38.605	42148	45700
P612	02.04.2016	15:59	16:11	37°42.048	15°38.605	37°42.315	15°37.788	45700	45828
P700	02.04.2016	17:04	21:14	37°41.728	15°37.118	37°31.166	15°20.652	46000	48587
P701	02.04.2016	21:14	03:02	37°31.166	15°20.652	37°10.30	15°30.82	48587	52213
P702	03.04.2016	03:02	05:30	37°10.30	15°30.82	37°00.44	15°31.05	52213	53724
P703	03.04.2016	05:30	06:06	37°00.44	15°31.05	37°01.47	15°32.88	53724	54106
P800	03.04.2016	13:43	17:55	37°31.90	15°25.85	37°32.61	15°46.66	55057	58179